

ENCLOSURE SLOT IDENTIFICATION BY MODULES

Inventors: Thomas Richardson  
1720 Rimrock Street  
Golden, Colorado 80401

and

Mohamad El-Batal  
3906 West 103<sup>rd</sup> Avenue  
Westminster, Colorado 80031

CITIZENS OF THE UNITED STATES

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## FIELD OF THE INVENTION

The present invention relates generally to enclosures for electrical modules or cards and, more particularly, to an apparatus and method wherein the modules identify the slots in which they are inserted.

## BACKGROUND OF THE INVENTION

It is often necessary to determine the location of an electronic module or circuit board, or a data storage module in a plurality of slots of an enclosure, such as a storage array enclosure, in which the module or circuit board is installed. For example, several slots or locations may hold identical modules having different functions within the system of such modules. Among the reasons for using identical modules are cost savings, and a reduction in the error rate associated with introducing an incorrect module into a bin which appears to be identical to other slots. Such modules are referred to as customer replaceable units (CRUs) or field replaceable units (FRUs). In order that a particular module operate in accordance with its desired function within a group of modules, the module needs to "know" in which slot it has been placed. Once its location is identified, pre-programmed circuitry in the module can perform properly. A similar situation exists for data storage modules within a storage array enclosure.

Existing solutions to this problem rely on a number of electrical pins having been reserved for this purpose in the electrical connector for a specific slot or bin, and sensed by the inserted CRUs and FRUs. However, with increasing complexity of functions for current CRUs and FRUs is such that there are insufficient uncommitted connection pins available for the specific function of slot location analysis.

Accordingly, it is an object of the present invention to provide a method and apparatus such that an electronic module or data storage module can determine in which slot it has been located and establish its particular function therein.

Additional objects, advantages and novel features of the invention will be set forth in part in the description which follows, and in part will become apparent to those skilled in the art upon examination of the following or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by

means of the instrumentalities and combinations particularly pointed out in the appended claims.

### SUMMARY OF THE INVENTION

To achieve the foregoing and other objects, and in accordance with the purposes  
5 of the present invention, as embodied and broadly described herein the apparatus for determining the function of a circuit board disposed in a slot in an enclosure and in electrical communication with the enclosure, hereof includes means located within the enclosure for displaying a characteristic of the slot; means disposed on the circuit board for detecting the characteristic of the slot; and a controller or processor for interpreting  
10 the detected characteristic and for directing the circuit board to perform the function associated therewith.

In another aspect of the invention in accordance with its objects and purposes the method for determining the function of a circuit board disposed in a slot in the interior of an enclosure and in electrical communication with the enclosure, hereof  
15 includes displaying a characteristic of the slot inside of the enclosure; detecting the displayed characteristic; interpreting the detected characteristic; and directing the circuit board to perform the function associated with the interpreted characteristic of the slot.

Benefits and advantages of the present invention include the use of circuit boards having identical electrical components, but having different functions.

### BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and form a part of the specification, illustrate the embodiments of the present invention and, together with the description, serve to explain the principles of the invention. In the drawings:

25 FIGURE 1a is a schematic representation of a side view of an embodiment of the apparatus of the present invention showing an enclosure having horizontal tabs projecting into its interior in such a manner that the number and location of these tabs can be determined by tab sensing elements located on a circuit board inserted into a slot in the enclosure, while FIG. 1b is a schematic representation of a perspective view  
30 of the apparatus illustrated in FIG. 1a hereof showing a configuration of tabs being detected by tab sensing elements once the card is fully inserted into the slot.

FIGURE 2 shows two examples of tab configurations, where the left configuration represents 1010 binary or 10 decimal and the right configuration represents 0100 binary and 4 decimal when read by the sensing elements.

FIGURE 3 is a schematic representation of a perspective view of another embodiment of the present apparatus showing sensors adapted for determining the identification of a slot in response to a signal pattern generated by the upper surface of the enclosure, and disposed in the vicinity of the pin connector of the printed circuit.

FIGURE 4a is a schematic representation of a perspective view of yet another embodiment of the invention showing a plurality of microswitches disposed on the surface of the printed circuit board in the vicinity of the pin connector, while FIG. 4b is a schematic representation of a side view of the printed circuit partially inserted into a bin slot, showing projections located on the top surface of the bin corresponding to certain of the microswitches on the surface of the card, such that from the number and disposition of the matching projections and microswitches, the identification of the slot can be determined.

#### DETAILED DESCRIPTION

Briefly, the present invention includes an apparatus and method for enabling a circuit board or data storage module, as examples, located within a slot or bin in an enclosure to determine the identification of the slot by detecting a characteristic feature of the slot. In this manner the circuit board or data storage module can operate in accordance with the function of that slot. This is particularly important when a plurality of slots or enclosure locations contain identical modules having different functions.

In accordance with one embodiment of the present invention, each slot in an enclosure that houses multiple CRUs has a set of mechanical tabs arranged in a binary fashion. The binary representation for each slot in an enclosure is chosen such that when a CRU is placed in the slot a sensing apparatus determines the configuration of the tabs and reports the configuration to circuits or processors located on the CRU that determine the function of the CRU from this information. Thus, each CRU can identify its unique slot location within the enclosure. If a chosen CRU is moved to another location, it identifies the new location based on the mechanical binary configuration of

the new slot. In this manner, CRUs can be removed for service operations such as repair or upgrading, and replacement CRUs can be inserted into the same slot with certainty of their function within the overall system.

5 A variety of sensors may be used to determine the presence or absence of a mechanical tab, including micro switches, Hall-effect devices, or LED sensors, or a combination of these or other devices. The number of tabs is determined by the number of slot locations to be uniquely identified.

Reference will now be made in detail to the present embodiments of the invention, examples of which are illustrated in the accompanying drawings. Similar or  
10 identical structure in the drawings will be identified by identical callouts. Turning now to the figures, FIG. 1a is a schematic representation of a side view of one embodiment of the apparatus of the present invention showing enclosure, **10**, having horizontal tabs, **12**, projecting into its interior in such a manner that the number and location of these tabs can be determined by tab sensing elements, **14**, located on printed circuit board, **16**, inserted into slot, **18**, of the enclosure. Guides, **20a** and **20b** insure proper  
15 alignment of printed circuit board **16** in enclosure **10**. In the embodiment shown in FIG. 1a, sensing element **14** includes a photodetector which detects the presence or absence of light generated by light source, **22**. Light source **22** can be supported by wall, **24**, of enclosure **10**, the same wall which supports tabs **12**, and powered externally  
20 to printed circuit board **16**, or supported by printed circuit board **16** and powered by light source power supply, **26**, as shown. Light source **22** may be a light emitting diode, and photodetector **14** may be a photocell or a charge-coupled detector, as examples. In operation, all of the light sources would be illuminated such that light detected by sensing elements **22** depends on whether a tab **12** is blocking the pathway between  
25 light source **22** and sensing element **14**. It should be mentioned that the tab can simply reduce the signal reaching the sensing element, rather than blocking it. A single charge-coupled detector might be utilized to detect the pattern. The detected light pattern is a binary representation of the identity of slot **18**, and permits printed circuit board **16** to adjust its function in accordance with this pattern using controller or  
30 processor, **28**, which receives the light pattern detected by sensing elements **14** and selects the operation of printed circuit board **16** in accordance therewith. As stated, and

without limiting the present invention, printed circuit board **16** can be a data storage module, and enclosure **10** may include a plurality of slots **18**. The function of circuit boards having identical hardware is directed by firmware responsive to the identity of the slot or bin in which the circuit board is inserted.

5       FIGURE 1b is a schematic representation of a perspective view of the apparatus illustrated in FIG. 1a hereof showing a configuration of tabs **12a** and **12b** detected by tab sensing elements **14a-14d** once card **16** is fully inserted into slot **18**. Clearly, tabs **12** can be fabricated from any material which substantially reduces the transmission of light therethrough. Other examples of sensing elements for detecting the presence of  
10       absence of tabs include Hall-effect sensors responsive to electric currents impressed on circuits located on printed circuit board **16**, or on a wall of enclosure **10**, where the magnitude of the effect is altered by an intervening tab. Microswitches responsive to projections on the wall of the enclosure adapted to depress such switches can also be used to accomplish the purposes of the present invention.

15       FIGURE 2 shows two examples of configurations for tabs **12**, where the configuration including tabs **12a** and **12b** represent 1010 binary or 10 decimal, while the configuration including tabs **12b**, **12c** and **12d** represent 0100 binary and 4 decimal when detected by sensing elements **14**. It is seen that when light is detected, a 1 is recorded and when the light is blocked by a tab, a zero is recorded in these examples.  
20       Clearly, the present apparatus could be configured such that the presence of a signal blocking tab represents a 1, while its absence represents a zero.

FIGURE 3 is a schematic representation of a perspective view of another embodiment of the present apparatus showing sensors **30a-30d** disposed in the vicinity of the pin connector, **32**, of card **16** adapted for determining the identification of a slot in  
25       response to signals generated by enclosure **10**, not shown in FIG. 3. Sensors **30a-30d**, can be photodetectors responsive to corresponding light emitting diodes located on the top inner surface of enclosure **10**, also not shown. The pattern displayed by the light emitting diodes disposed in enclosure **10** characteristic of the binary signature of the slot is detected by photodetectors **30a-30d** to provide the bin identification to card **16** for  
30       use in determining its function. Clearly, sensors **30a-30d** can be located at any position on card **16** which has an unimpeded pathway to the light-emitting diodes located in

enclosure **10**, such that the diode light pattern impressed on the diodes can be detected thereby.

FIGURE 4a is a schematic representation of a perspective view of yet another embodiment of the invention showing a plurality of microswitches, **32a-32d**, disposed in the vicinity of pin connector **34** of printed circuit board **16**, while FIG. 4b is a schematic representation of a side view of printed circuit board **16** partially inserted into slot **18** of enclosure **10**, showing projections, **36**, directed downward from the top inner surface of the enclosure in the vicinity of matching pin connector, **38**, to connector **34** and adapted to actuate certain of the microswitches **32a-32d** on printed circuit board **16**. From the number and disposition of the matching projections and microswitches, the identification of the bin can be determined.

The foregoing description of the invention has been presented for purposes of illustration and description and is not intended to be exhaustive or to limit the invention to the precise form disclosed, and obviously many modifications and variations are possible in light of the above teaching. The embodiments were chosen and described in order to best explain the principles of the invention and its practical application to thereby enable others skilled in the art to best utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto.